



SURFACE VEHICLE STANDARD

J3109™

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PWM HVAC Blower Controller and BLDC Motor Controller Efficiency Assessment

RATIONALE

Legislation has been introduced that provides credits for the use of emission reduction technologies. One such technology is the use of a Pulse Width Modulated (PWM) HVAC Blower Controller (together with a brushed DC motor) or a Brushless DC controller (with Brushless DC motor) in place of traditional HVAC Blower Controllers such as resistors or Linear Power Modules. A uniform standard does not exist to evaluate the efficiency of such controllers and estimate the impact towards emissions and qualify for credit with the legislative bodies.

Latest revision includes minor corrections and clarifications.

1. SCOPE

The intention of this standard is to establish a framework to measure the efficiency of PWM HVAC Blower Controllers and Brushless DC Motor Controllers and define a usage based overall efficiency. This result can then be used by vehicle OEMs to demonstrate compliance towards requirements or benchmarks established by regulatory agencies.

2. REFERENCES

2.1 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

EPA-HQ-OAR-2010-799; FRL-9706-5; NHTSA-2010-0131: 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards

3. DEFINITIONS

All physical dimensions and units are expressed in SI units and all voltage is assumed to be in Direct Current (DC) unless otherwise noted.

3.1 PULSE WIDTH MODULATION (PWM)

Pulse-width modulation (PWM) is a modulation process or technique used to control output power supplied to electrical devices, especially to inductive loads such as motor, by means of switching between supply and load on and off at a high frequency. In this document, PWM will also be used to describe an HVAC blower controller using this control method.

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Documents

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3.2 LINEAR POWER MODULE (LPM)

An HVAC blower controller which operates a transistor in a linear mode to control output voltage to an HVAC blower motor.

3.3 VARIABLE BLOWER CONTROLLER (VBC)

Another name for a Linear Power Module.

3.4 BRUSHLESS DC MOTOR (BLDC)

A motor that is commutated via electronic switching rather than a brush and commutator.

4. EQUIPMENT

4.1 DC Power Supply (Regulated): 0 to 20 V and 0 to 40 A

4.2 Signal generator or LIN-BUS Master device to provide set point to LIN-based controllers

4.3 For PWM and Brush DC motor

4.3.1 All voltage measurement equipment shall be accurate to within 0.05% of reading at 20 KHz square wave signal with average measurement.

4.3.2 Current shunt: 100 A/100 mV at $\pm 0.1\%$

4.4 For BLDC Controller

4.4.1 Oscilloscope (One Needed)

- High-end oscilloscope for advanced math functions and deep memory
- Minimum of four channels
- ≥ 20 MHz bandwidth, sampling rate ≥ 10 MS/s, ≥ 8 -bit resolution
- Sample memory depth ≥ 10 MS

4.4.2 Current Probes (Minimum of Two Needed)

- Bandwidth ≥ 1 MHz
- Range 30 to 50 A
- Note: Rogowski coils and current transformers cannot be used. Only DC-capable probes can be used.

4.4.3 Differential Voltage Probes (Minimum of Two Needed)

- Bandwidth: ≥ 20 MHz
- Range: ≥ 20 V, but ≤ 100 V

5. PWM CONTROLLER WITH BRUSHED DC MOTOR

5.1 Test Set-Up

5.1.1 Load

The load shall be set with 13.5 V at the power input of the PWM Controller and the set point input to the controller (duty cycle or LIN) shall be adjusted to provide 12.5 V_{avg} output to the load.

5.1.1.1 Using HVAC Blower

With the electrical input to the PWM Controller adjusted as described in 5.1, restrict the inlet or outlet of the HVAC blower such that the current draw is in accordance with the current listed in Table 2.

5.1.1.2 Using Load Simulator

With the electrical input to the PWM adjusted as described in 5.1, select an inductive-resistive load to draw the currents listed at the respective voltages in Table 2. The inductance shall be 70 to 200 μ H. The resistance can be adjusted by use of different values of resistors set in parallel or series, or a sufficiently sized variable resistor, in order to obtain the targeted current draw.

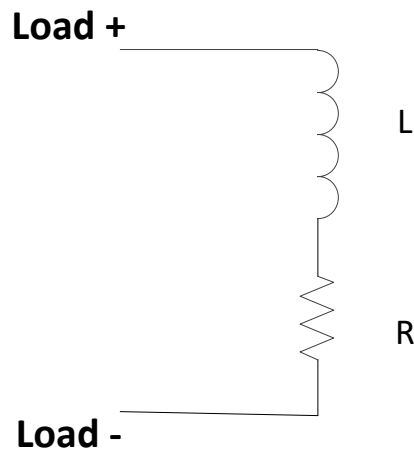


Figure 1 - Example of load simulator

5.1.1.3 Wire Connection

3.0 mm² or 12 AWG wire of a length of 150 mm $\pm$ 10 mm from connector to connector (wire insertion side) shall be used to connect the power module to the blower motor or resistive load.

5.1.1.4 Test Diagram

Components and instrumentation shall be set-up in accordance with the following diagrams: